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HAEMATOLOGICAL STUDIES IN TRYPANOSOMIASIS OF CATTLE

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INTRODUCTION

The course of trypanosomiasis of cattle, due to infection with *Trypanosoma congolense* or *T. vivax*, is divided into two clearly defined stages: 1, the acute, with pre-critical and critical phases: 2, the chronic, which is post-critical, Fiennes, Jones & Laws (1946), Fiennes (1950). During the acute stage, there occurs a macrocytic anaemia; during the chronic stage, the anaemia is microcytic (Charts I & II). As will appear later, the anaemia is due to two sets of changes: 1, of the red blood cells: 2, of the blood plasma. These changes, operating in different proportion, determine four different courses of the disease, which will be considered.

1. *The Hyperacute Course.*—The hyperacute form of the disease is one in which severe haemolysis is accompanied by hydraemia. It is rapidly fatal.

2. *The Acute Course.*—In the acute course, haemolysis is less severe in the early stages. There is an initial hydraemia, which is followed by dehydration. The end point is death at the time of a haemolytic crisis.

3. *The Chronic Course.*—The early stages of the chronic course are similar to those of the acute, but hydraemia persists without dehydration. The haemolytic crisis, when it comes, does not prove fatal, and the animal enters upon a chronic wasting disease, which may persist for months, until the fatal termination.

4. *The Recovery Course.*—Recovery without treatment occurs exceptionally after several months of infection. In this form of the disease, the hydraemic factor is either absent or of rare occurrence.

Some of the changes, which occur in the blood of cattle suffering from the hyperacute, acute, and chronic courses of the disease, are shown in Charts III to V. Those occurring during the recovery course are shown in Charts I and II and in Regressions I and II. It will be seen that the outstanding difference in every case lies in variations of the specific gravity of the plasma. It will be necessary to study these variations, but firstly some note must be taken of the variations, which occur in the blood of normal cattle.

CHANGES OF THE HAEMATOLOGICAL PICTURE OF NORMAL CATTLE

The blood of normal cattle at Kabete shows two types of variation: 1, diurnal; 2, cyclical.

The Diurnal Changes. Some mention of the diurnal changes has been made by Fiennes (1952a, b). They are associated with changes of activity and can be provoked and intensified by injections of adrenalin. Within the space of a single hour, red cell counts may move upwards or downwards to an extent of 2,000,000 cells per cm. If the counts are initially high, the movement is downwards and conversely. A downward movement of the counts is usually accompanied by a reduction of the specific gravity of the plasma; the specific gravity being proportional to the solids content (Regression III). The reduced erythrocyte counts are, therefore, due to dilution of the blood, and the actual circulating red cells may be increased and not diminished; an instance, in which reduced counts were accompanied by increased circulating red cells will be encountered later (Table I).

TABLE I

OX NO. 3237, SHOWING VOLUME CHANGES OF BLOOD, ETC., DURING THE COURSE OF ACUTE INFECTION WITH *T. congolense*

Day	Condition	R.b.c.	Plasma sp. gr.	Volume red cells	Volume plasma	Volume blood
	Uninfected	7·2	1·027	4·9 (2·5%)	8·8 (4·3%)	13·7 (6·8%)
3rd	phase 1	8·0	1·028	4·7 (2·2%)	8·3 (3·9%)	13·0 (6·1%)
6th	phase 1	6·5	1·024	6·0 (2·7%)	12·5 (5·8%)	18·5 (8·5%)
12th	phase 2	4·6	1·024	3·1 (1·0%)	9·2 (4·2%)	12·3 (5·2%)
32nd	chronic	3·1	1·022	2·0 (1·0%)	8·8 (4·6%)	10·8 (5·6%)

Volumes are given in litres and % of bodyweight.
Day = day after discovery of trypanosomes in blood smears.
R.b.c. = numbers of red blood cells, millions per cm.
Sp. gr. = specific gravity.

In response to activity, then, there is an increase of circulating blood volume and a rearrangement of the cell/fluid ratio.

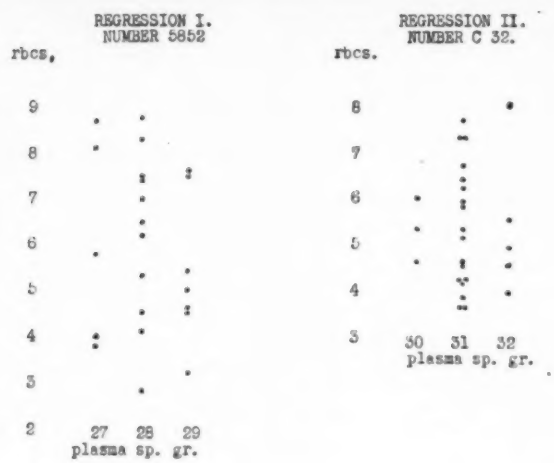
The Cyclical Changes. The cyclical changes have also been described by Unsworth (1949). In contrast to the diurnal changes, they are not connected with changes of dilution in the plasma. The changes, which occurred in the blood of two cattle over a 50-week period, are shown in Charts VI and VII. Periods of low red cell counts, accompanied by high mean corpuscular volume (m.c.v.), alternated with periods of high red cell counts and low m.c.v. There was a close correlation between m.c.v. and mean corpuscular haemoglobin (m.c.h.), because packed cell volumes and haemoglobin figures were less variable than red cell figures (Charts VIII and IX).

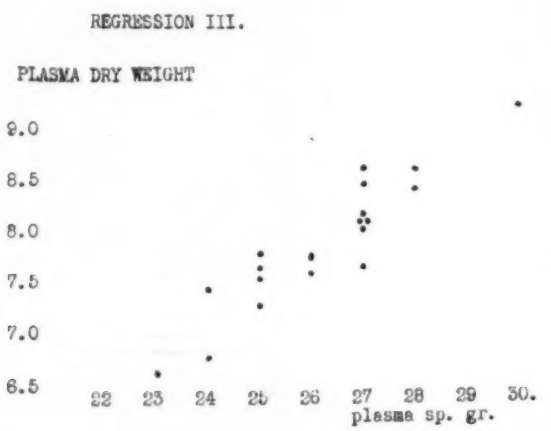
This cycle must be regarded as an erythropoietic one, dependent on periods of intensified destruction of the smaller and older red cells.

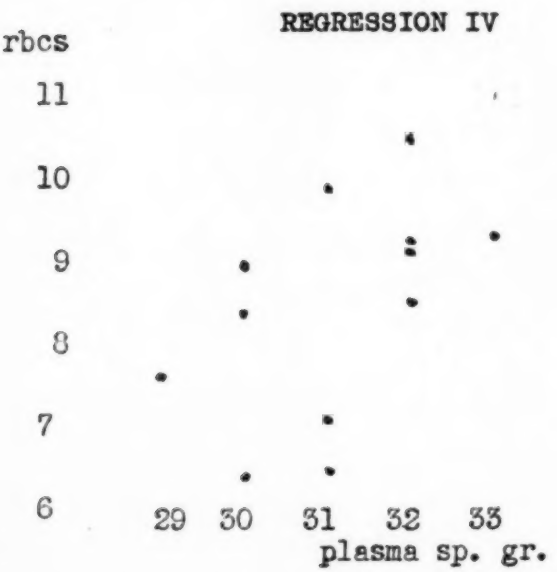
CHANGES OF THE BLOOD IN TRYPANOSOME INFECTED CATTLE

1. *The Pre-critical and Critical Stages*

The typical course of the anaemic changes is best shown by ox No. 3273, Chart III, which suffered from the acute form of the disease. Three sequences occurred. During the first sequence, red cell counts and specific gravity of the plasma were both reduced. This sequence was shared by ox No. 3304, a hyperacute case, Chart IV, and by ox







No. 3237, a chronic case, Chart V. No 3304 required to be treated at this stage in order to save its life. The second sequence occurred in both No. 3273 and No. 3237; alternate improvement and decline of red cell counts were inversely related to plasma specific gravity levels; this, as has been seen, is the opposite relationship to the normal. During the third sequence, there were low red cell counts accompanied by high specific gravity levels of the plasma in No. 3273, and low red cell counts with low specific gravity levels of the plasma in 3237. The low red cell counts of 3237, with accompanying hydraemia, indicate a less severe loss of erythrocytes than the low red cell counts of 3273, which, as will be seen, suffered from a degree of dehydration, a feature of acute critical cases.

Table I shows estimations of total circulating blood, red cell, and plasma volumes in the case of No. 3237. During the first sequence, the plasma was increased in volume and diluted; both blood and erythrocyte volumes were also increased, in spite of the reduced red cell counts. The condition was, therefore, hydraemia, not anaemia.

During the second sequence, circulating plasma volumes were restored to the pre-infection level, but specific gravities remained below normal. Erythrocyte volumes were reduced, and, consequently, total blood volumes. There had thus been removal of both plasma solids and erythocytes. The extent of the removal of plasma solids is shown in Table II.

Table II

Showing Changes of the Circulating Plasma Solids During the Course of Infection of No. 3237 with *T. congolense*

Day	Sp. gr. of plasma	Volume of plasma in litres	Total plasma solids, grammes.
	1·027	8·8	730
3rd	1·028	8·3	734
6th	1·024	12·5	899
12th	1·024	9·2	662
32nd	1·022	8·8	590

Sp. gr. = specific gravity.
Day = day after discovery of trypanosomes in blood smears.

Total circulating haemoglobin, together with haemoglobin percentages, are shown in Table III. A true anaemia had thus developed, reflected by a genuine reduction of the circulating red cells and by a fall of the haemoglobin content of the blood, much more severe than is indicated by figures for haemoglobin percentages. At the same time, there had been a loss of plasma solids.

Table III

Showing Changes of Total Circulating Haemoglobin in the Blood of Ox No. 3237, During the Course of Infection with *T. congolense*

Day	R.b.c. millions	R.b.c. volume	Hb gm. 100 c.c.	Circulating Hb. in grammes.
	7·2	4·9	8·7	426
3rd	8·0	4·7	8·7	409
6th	6·5	6·0	6·7	402
12th	4·6	3·1	6·0	186
32nd	3·1	2·0	5·2	104

R.b.c. = red blood cells, millions per cm.
R.b.c. = ,, ,, ,, volume in litres.
Hb. = haemoglobin in grammes per 100 c.c. of blood.
Day = day after discovery of trypanosomes in blood smears.

CHART I

NUMBER C 32.

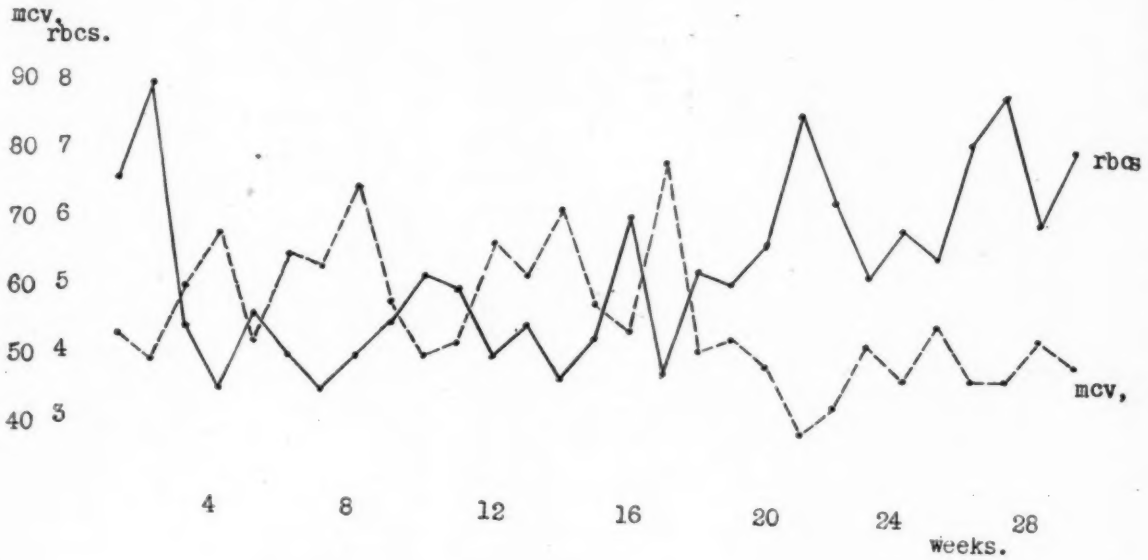


CHART II.

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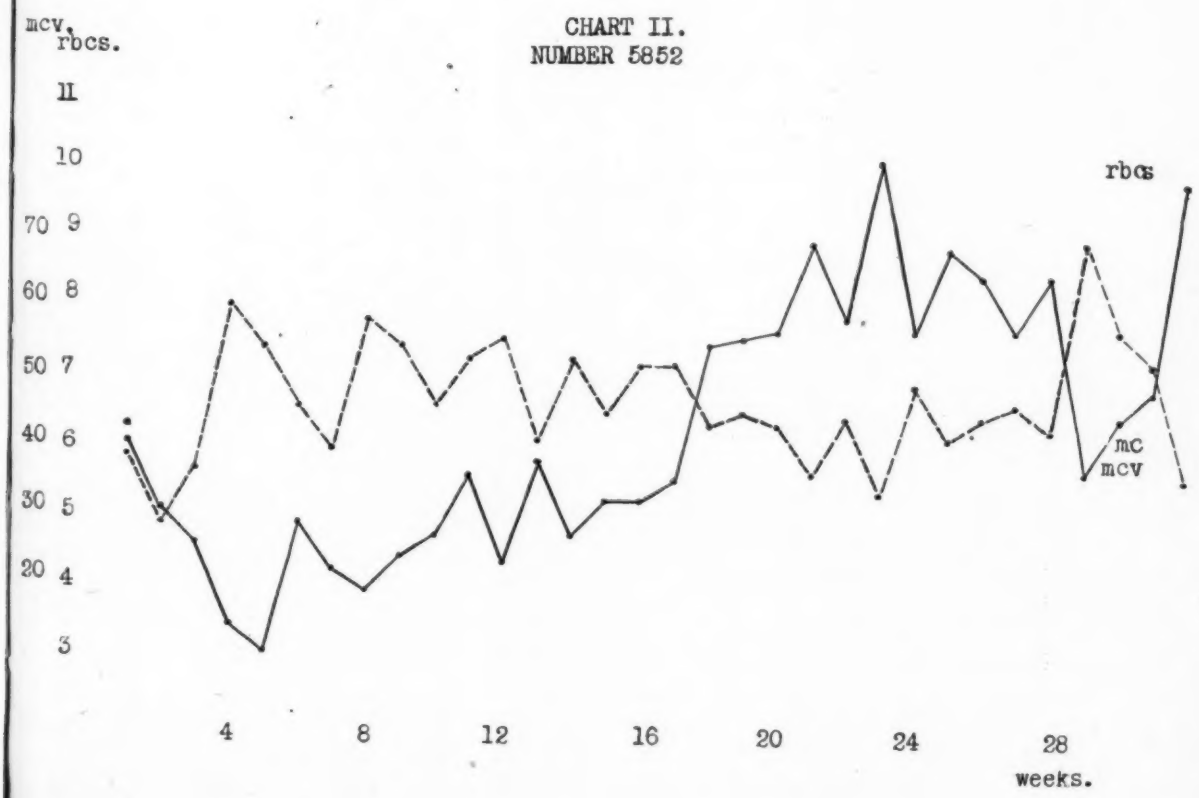


During the third sequence, the circulating plasma volume and circulating solids were still further reduced; the specific gravity of the plasma remained low. No true haemolytic crisis developed.

During the third sequence of No. 3273, however, a crisis did develop. There was haemolysis, as indicated by positive indirect van den Bergh reactions—*vide infra*—together with all the signs of critical collapse. In this case, unlike that of 3237, there was a rise of the specific gravity of the plasma; although blood volume estimations were not made for this animal, the rise was undoubtedly due to loss of water, resulting in dehydration. Instances of such dehydration in terminal critical cases are shown in Table IV.

TABLE IV

SHOWING THE BLOOD PICTURE IN THE EXTREME AND TERMINAL STAGES OF *T. congolense* INFECTION

Date	Number	R.b.c.	Plasma sp. gr.	v an den Bergh
29/5/52	2710	1·9	1·025	indirect +
4/7/52	3232	2·0	1·024	indirect +++
5/7/52	3005	2·4	1·027	indirect +++
7/7/52	3005	2·6	1·027	indirect +++

Number 3282

Date	R.b.c.	Plasma sp. gr.	Volume red cells	Volume plasma	Volume blood
9/7/52	1·8	1·023	1·2 (0·6%)	8·0 (4·0%)	9·2 (4·6%)

Volumes are given in litres and % of bodyweight.
R.b.c. = red blood cells in millions per cmm.
Sp. gr. = specific gravity.

The effects of treatment at the time of crisis are shown by Charts X and XI; no apparent improvement occurred for some eight weeks. The real results, however, are shown in Table V. Following the removal of parasites, there was an immediate rise of plasma specific gravities and of blood and erythrocyte volumes. This is direct evidence that plasma changes are attributable to the parasites and further reference will be made to it.

TABLE V

SHOWING CHANGES IN THE BLOOD PICTURE, FOLLOWING TREATMENT OF CATTLE FOR INFECTION WITH *T. congolense*

Day	Condition	R.b.c.	Plasma sp. gr.	Volume red cells	Volume plasma	Volume blood
			Number 3246			
	infected	4·4	1·023	2·1 (1·3%)	6·3 (4·1%)	8·4 (5·4%)
5th	treated	3·9	1·026	3·9 (2·6%)	8·0 (5·3%)	11·9 (7·9%)
23rd	treated	4·2	1·027	2·8 (2·0%)	7·1 (5·3%)	9·9 (7·3%)
27th	treated	4·1	1·028	2·8 (2·2%)	8·5 (6·5%)	11·3 (8·7%)
			Number 3237			
	infected	3·1	1·022	2·0 (1·0%)	8·8 (4·6%)	10·8 (5·6%)
5th	treated	3·9	1·022	2·7 (1·5%)	9·6 (5·2%)	12·3 (6·7%)
9th	treated	3·0	1·022	2·5 (1·3%)	9·9 (5·4%)	12·4 (6·7%)

Volumes are given in litres and % of bodyweight.
R.b.c. = red blood cells in millions per cm.
Sp. gr. = specific gravity.
Day = day after treatment.

II. Correlation of Blood Changes

The correlations between the blood changes and the level of parasitaemia have been studied in detail, and a large number of Regressions were prepared showing the relationships which existed. Space does not permit of their reproduction, but it will be necessary to give a brief account of these relationships, where they throw light on the nature of the anaemia.

Parasitaemia.—When trypanosome numbers in the blood are high, red cell counts also tend to be high. It may be inferred that red cell destruction is intensified at times of trypanolysis. This is the generally accepted view.

Reticulocytes tend to be depressed when parasites are numerous, but to improve when parasites are scanty. This shows that there is an inhibiting influence by the living parasites on the output of red cells, an accepted mechanism in malaria.

It has already been shown that plasma changes are a direct effect of parasitism.

The following changes can, therefore, be attributed to the direct action of the parasites:—

(*a*) Destruction of red cells at times of trypanolysis (it will be shown later that dying trypanosomes produce haemolysin).

(*b*) Inhibition of red cell output from the bone marrow, when parasites are numerous in the blood.

(*c*) Changes of the dilution, solid content, and volume of the circulating blood plasma.

The Size of the Red Cells.—In the acute, haemolytic case, No. 3273, increased cell size was associated with high parasite counts; in the chronic hydraemic case, No. 3237, increased cell size was associated with low parasite counts. There was no correlation between cell size and plasma specific gravity, except in the chronic hydraemic case, in which cell size was increased, when specific gravities were low. There thus occurs a dual influence in the development of macrocytosis, haemolysis and hydraemia; as will be seen, in the former event the red cells show morphological abnormalities, which are absent from the latter.

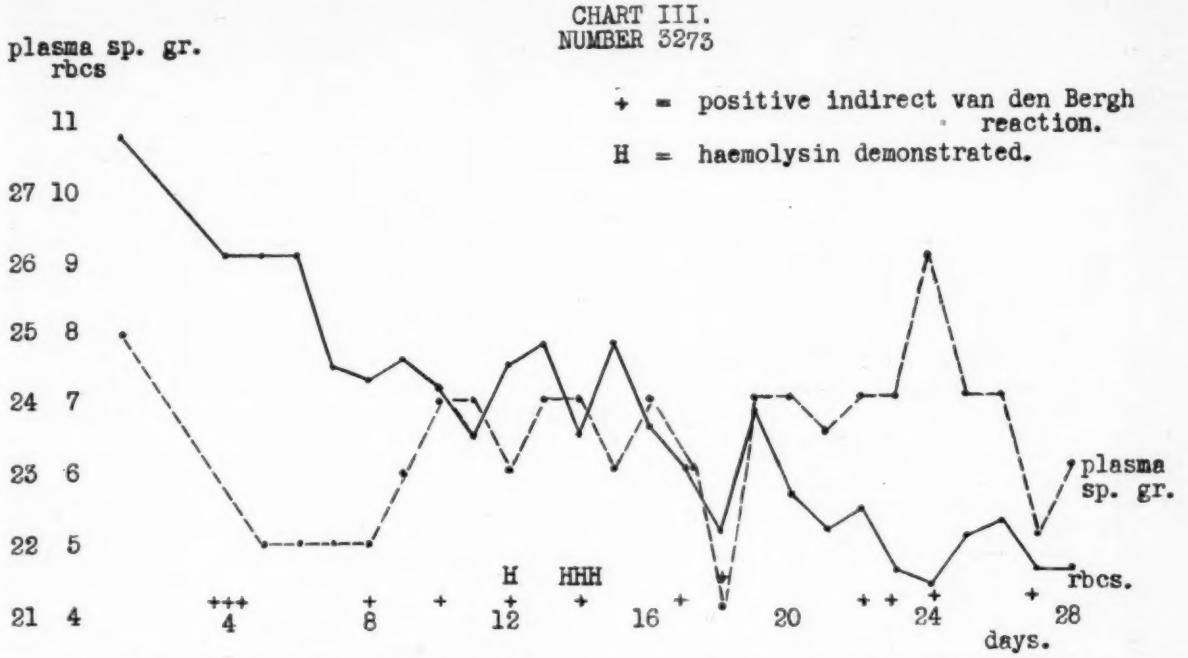
In all cases, cell size was inversely related to cell numbers, as in normal cattle.

Cellular Haemoglobin.—In all cases, larger cells carried a greater weight of haemoglobin, as in the case of normal cattle.

Mean corpuscular haemoglobin concentration (m.c.h.c.) was low in the hyperacute case, No. 3304, but the cells tended to be large. In the acute case, N. 3273, m.c.h.c. was reduced in the larger cells. In the chronic case, No. 3237, there was no correlation between cell size and m.c.h.c.

Thus, in the acute cases, macrocytes with a poor percentage of haemoglobin were preponderant; in the hydraemic case, there was a greater percentage of normal cells, irrespective of size. The conclusion that macrocytosis is dependent on dual influences is hereby supported.

Plasma Changes.—Regression IV shows the relationship between red cell counts and plasma specific gravities in 12 normal adult cattle. These cattle were in two "states" of red cell levels, as appears from the two parallel regression lines. In infected cattle, the relationship between red cell counts and plasma specific gravities may be disturbed, depending on the phase and type of the disease. In the chronic, hydraemic case, No. 3237, the red cell/plasma specific gravity regression showed in general the normal gradient from left to right. In the hyperacute case, No. 3304, the gradient (first sequence only) also tended to be normal. In the acute case, No. 3273, the gradient was found to be reversed, provided that only the first two sequences were plotted; thus, red cell counts were high at times when specific gravity was low, and conversely; this indicates periods of severe red cell destruction, alternating

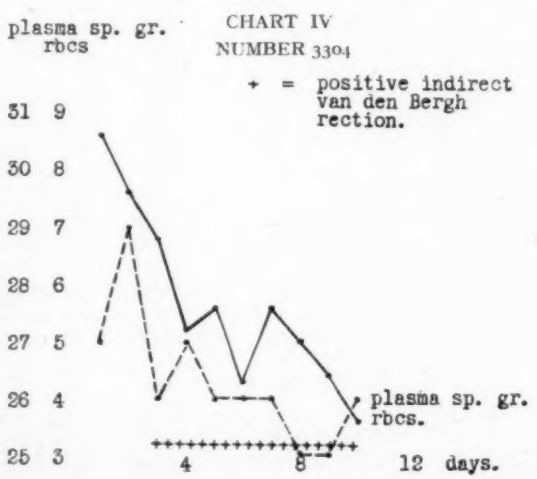


with strong efforts at recovery. When third sequence figures are added to this regression, no correlation is found, the whole relationship being upset by a new factor already noted, loss of water.

Morphological and Physiological Changes

1. *Anisocytosis.* Price-Jones curves were not prepared either for normal or infected cattle. It cannot, therefore, be said at what stage abnormal red cell ranges become developed. At Kabete, the red cells of normal cattle often show considerable variations of size in a single blood smear. In infected cattle, this variation became intensified, until it was extreme at the crisis. The macrocytes at the time of crisis were hypochromic and stained poorly at the centre of the disc.

During the post-critical stages of the disease macrocytes disappear, but anisocytosis remains a feature because of the presence of microcytes. Often at this stage, red cell counts are high and may reach 10,000,000 per cmm. or more. In spite of this, haemoglobin and haematocrit percentages usually remain low, because of the small size of the cells and their poor haemoglobin content (Charts I and II).



2. *Abnormal Red Cells.* At the time of crisis, blood smears are typical of a macrocytic anaemia of haemolytic origin. Normoblasts can usually be found and also more primitive cells of the normoblastic series. Punctate basophilia and cells with Cabot rings are not infrequent. The picture is variable and, even where macrocytosis is severe, punctate basophilia may be absent. After the crisis, except in relation to size, abnormal red cells disappear.

3. *Reticulocytes.* Reticulocytes in the blood of normal cattle were found to range from 5 per cent. to 7 per cent. Unfortunately, no series of counts was made from one animal over a period, so that the normal variations are not known. When trypanosomes appeared in blood smears, numbers of reticulocytes fell, sometimes as low as 0·1 per cent. As already shown, they were most numerous when parasites were rare. Following treatment, numbers rose to 25 per cent. or 30 per cent. This is evidence that a haemolytic factor exists.

4. *Breakdown Products of Haemoglobin.*—Breakdown products of haemoglobin were not normally present in the blood or urine of infected cattle, except for bilirubin. Traces of haemoglobin were found by spectroscopic examination in many normal ox plasmas, possibly the result of trauma in collecting the blood. No increase was found in the blood of infected cattle. Blood was examined from 17 animals, of which four were goats and two were sheep. All were infected with *T. congolense.* Methaemalbumin was absent from the blood of all the animals, and Schumm's test was negative. In one of them, an ox in the terminal stages of crisis, urobilin was present in the urine.

Results of daily van den Bergh tests during the acute stages of the disease are included in Charts III to V. No

direct positive reactions were ever found. Indirect reactions were constantly present in the hyperacute case, No. 3304, intermittently positive in the acute case, No. 3273, and infrequent in the mild case, No. 3237. Indirect positive reactions would, therefore, appear to be proportional to the severity of the case. Terminally, indirect positive reactions were always found, even in chronic cases. Haemolytic factors are, thus, a feature of pre-mortal collapse.

Although numerous tests have been made, no positive van den Bergh reactions have been encountered, except terminally, during the post-critical disease.

Circulatory and Vascular Changes

1. *Changes in the Blood Vessels.*—Fiennes (1946) demonstrated a specific action of *T. congolense* in causing dilatation of capillaries and veins. This dilatation is evident in histological preparations of all organs at all stages of the disease. In hyperacute cases of infection with *T. vivax* (unpublished data), it was found to be so severe that there were widespread haemorrhages throughout the body, resulting from rupture of capillaries. This vaso-dilatation has also (unpublished data) been demonstrated by histological examination of tissues from mice killed one to six hours after intraperitoneal injections of *T. congolense*. It is, therefore, a specific and prompt reaction to the presence of trypanosomes or of some agent produced by or from them.

The presence of vaso-dilatation and apparent congestion in histological preparations led to the assumption that haemostasis occurred. It was, however, demonstrated that, far from haemostasis occurring, the circulation time was greatly reduced in infected cattle. This was demonstrated in the following way:

Intravenous injections of 2 per cent. trypan blue were made into the right jugular veins of infected and normal cattle. Blood samples were collected from the left jugular veins at approximately 10 second intervals. Circulation times in normal cattle, as judged by the time taken for a blue coloration to appear in the test plasma, varied from 50 to 90 seconds. They were much reduced if the test animal became excited; for instance, in one ox which had been chased by the herdsmen, the circulation time was less then 10 seconds. In cases of acute infection with trypanosomiasis, circulation times averaged 20 seconds, the range being 15 to 50 seconds. In cases of chronic infection, circlation times averaged 30 seconds.

2. *The Condition of the Heart.*—Cardiac lesions may be found at all stages of infection with *T. congolense*, and Fiennes (1952c) demonstrated parasites in the cardiac capillaries in the chronic and cryptic types of disease.

There is no evidence that a cardiac incompetence exists of such severity as to contribute to the anaemia, in fact the reverse is suggested by the shortened circulation times.

3. *The Bone Marrow.*—From the outset of the disease, the red marrow of the long bones undergoes degeneration, Fiennes (1953). In the post-critical stages, it is usually replaced by yellow marrow and gelatinous material. The marrow of the sternum ribs and vertebrae appears on macroscopical examination to be unaffected.

Bone marrows have not been examined histologically during the course of the present investigations. The few made by Fiennes, Jones & Laws (1946) showed an excess of normoblasts. Small numbers of sternal punctures, made from time to time in calves, have confirmed this (unpublished data).

This condition resembles that of the bone marrow in malaria and suggests an inhibition of output from the red marrow, a conclusion already reached from studies of reticulocyte counts.

4. *The Spleen.*—During the pre-critical and critical stages, the spleen becomes greatly enlarged because of an increase of size of the Billroth cords and the sinuses. Both cords and sinuses become packed with red cells and a great variety of white cells, of which neutrophils and macrophages predominate. There are extensive deposits of haemosiderin, some lying free and some ingested by phagocytes. Many of the red cells appear to be normal, but many are in various stages of disintegration. Others are ingested by macrophages.

Two processes are at work: 1, removal of red cells from the circulation; 2, destruction of red cells. Owing to the large size of the organ and the extent of the haemosiderin deposits, it is evident that both contribute significantly to the development of anaemia.

During the post-critical stage, the spleen returns to a normal size and may even be atrophic. At this stage, therefore, interference by the organ with the red cells is not a factor in the causation of anaemia. It is not known what happens to the iron stored in the spleen, when the organ returns to a normal size. It is possible that the body, usually so retentive of iron, may excrete it. If so, iron deficiency would be a possible explanation of the microcytic anaemia in the post-critical stage.

5. *The Haemolymph System.*—From the onset of the disease, hyperplasia of the haemolymph system occurs. At first, tiny pin-point glands are developed, which grow to the size of grapes. These may be subcutaneous and palpable externally, attached to lymphatic or adrenal glands, or—in greatest abundance—along the dorsal surface of the thoracic trachea and attached to the stomachs. In cases of long standing, the glands may resemble clusters of grapes. They contain little lymphoid tissue but are packed with red cells, many of which are in the course of disintegration.

These glands evidently contribute to the effect of the spleen in removal and destruction of red cells. Unlike the spleen, they play some part in the chronic course of the disease.

6. *The Lymphatic System.*—A general hypertrophy of lymphatic tissue occurs throughout the body. The lymph nodes may be increased in number within a gland, but show central degeneration (Flemming's Centres). The hypertrophy mostly affects the cells of the reticulum. These, as shown by Fiennes (1952d), may contain masses of brown iron containing pigment, similar to malaria pigment but of obscure origin. Often, large stores of red cells are present in the medulla, many in a state of disintegration. Extensive deposits of haemosiderin are also frequently found.

Boycott & Price-Jones (1913), who studied the anaemia caused by *T. brucei* in rabbits, considered that the main causes were erythro-phagocytosis in the lymphatic glands together with inhibition of bone marrow activity. In the present cases, it is evident that the lymphatic glands were concerned in removal and destruction of red cells in company with the spleen and haemolymph glands.

The Causes of Anaemia

We have so far studied the nature of the changes which occur in the blood of cattle infected with trypanosomiasis, and the changes which occur in those organs which appear

to be most directly concerned with the development of anaemic symptoms. It remains to consider the actual mechanisms responsible for these changes, which lead to the development of disease in the acute and chronic stages.

1. *Haemolysis.*—Fiennes (1950), while testing trypanolytic sera against living trypanosomes on supra-vitally stained slide preparations, observed the haemolysis of red cells clustered round agglutination rosettes of *T. congolense*. Many attempts have been made to demonstrate haemolysin in trypanosomes, but this is believed to be the only occasion on which it has been shown. This demonstration shows firstly that *T. congolense* can cause haemolysis, secondly that it does so when in a moribund condition. Early workers, though they failed to demonstrate the presence of haemolysin in trypanosomes, had realised that trypanolysis and haemolysis occurred simultaneously.

The demonstration of haemolysin in the sera of infected cattle is not easily accomplished, probably because it is

CHART V
NUMBER 3237.

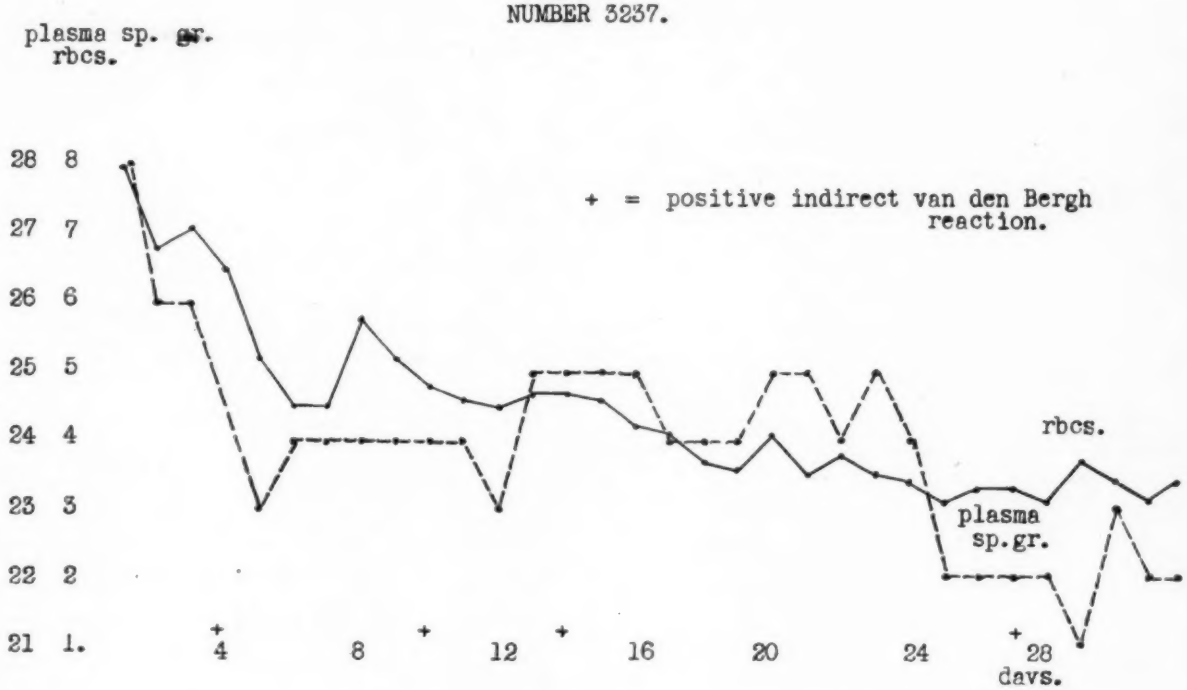
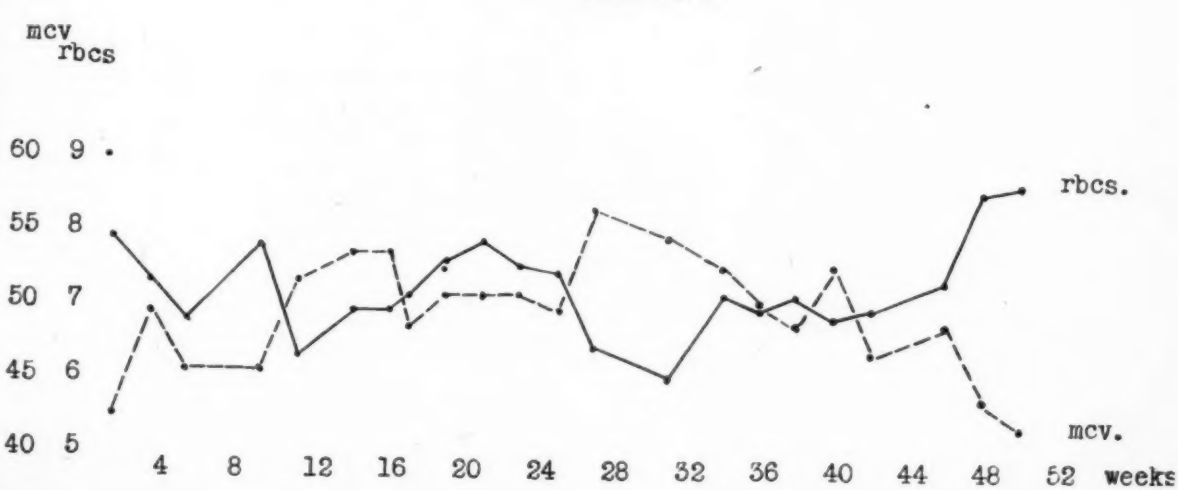


CHART VI.
NUMBER 1079



only present transitorily and at the rare intervals of active trypanolysis.

In the present work daily tests were made on plasmas from infected cattle. This was done by separating the infected plasmas and mixing them with normal ox red cells. Normal plasmas were also mixed with red cells from the infected animal. The mixed cells and plasmas were incubated at 37° C. for half an hour and compared for colour changes with the original plasmas.

Plasma from No. 3273 (Chart III) haemolysed red cells from a normal ox on two occasions; its own red cells were not haemolysed by normal plasma. Haemolysis did not occur when the plasma was inactivated at 56° C. in the water bath for half an hour.

Haemolysis was also demonstrated in the plasma of one ox in the terminal stages of *T. congolense* infection. In this case, plasma from the infected animal haemolysed normal ox red cells and the red cells from the infected

CHART VII.
NUMBER 1082.

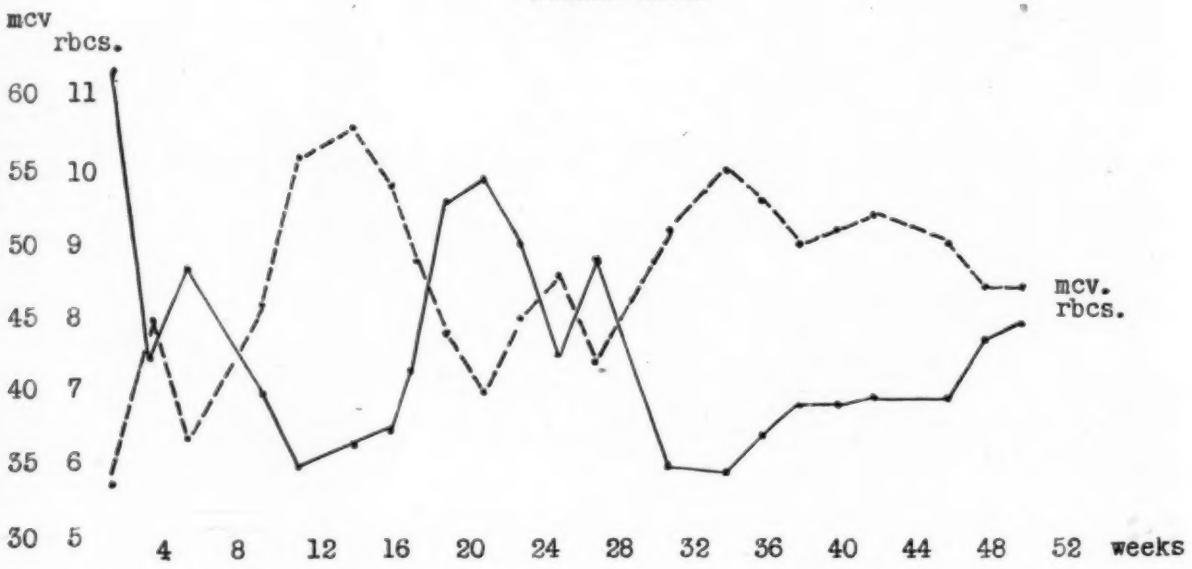


CHART VIII.
NUMBER 1079.

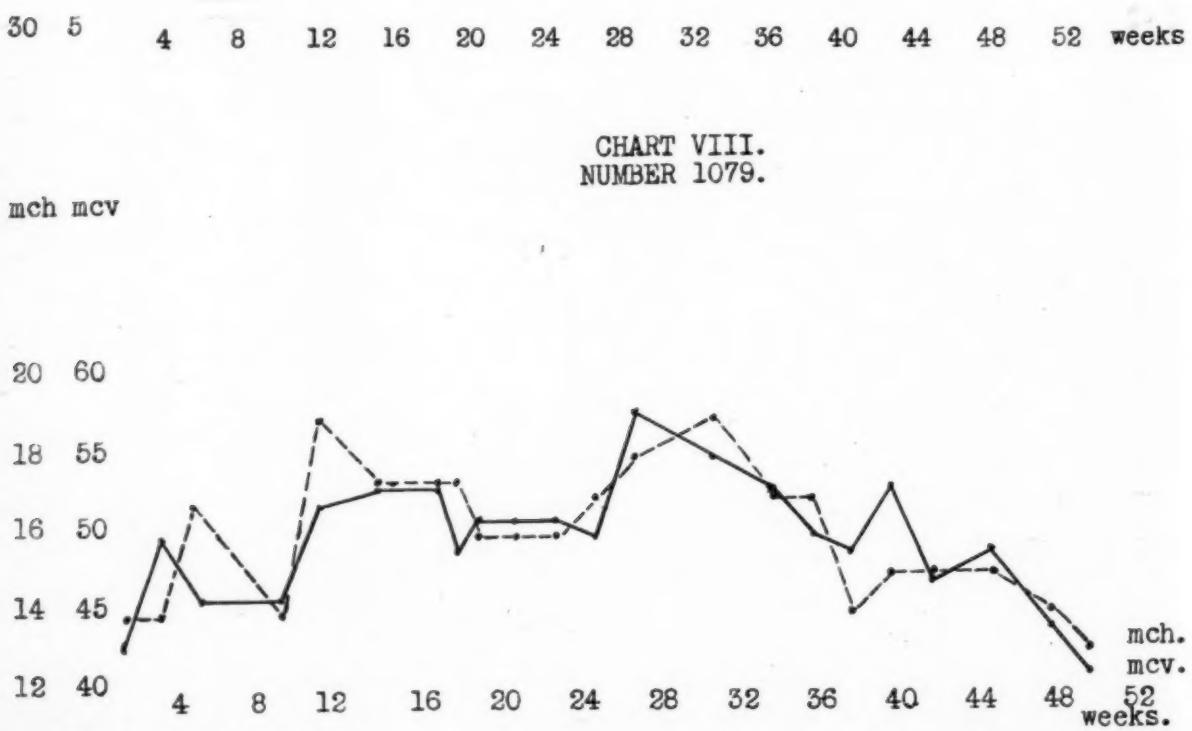
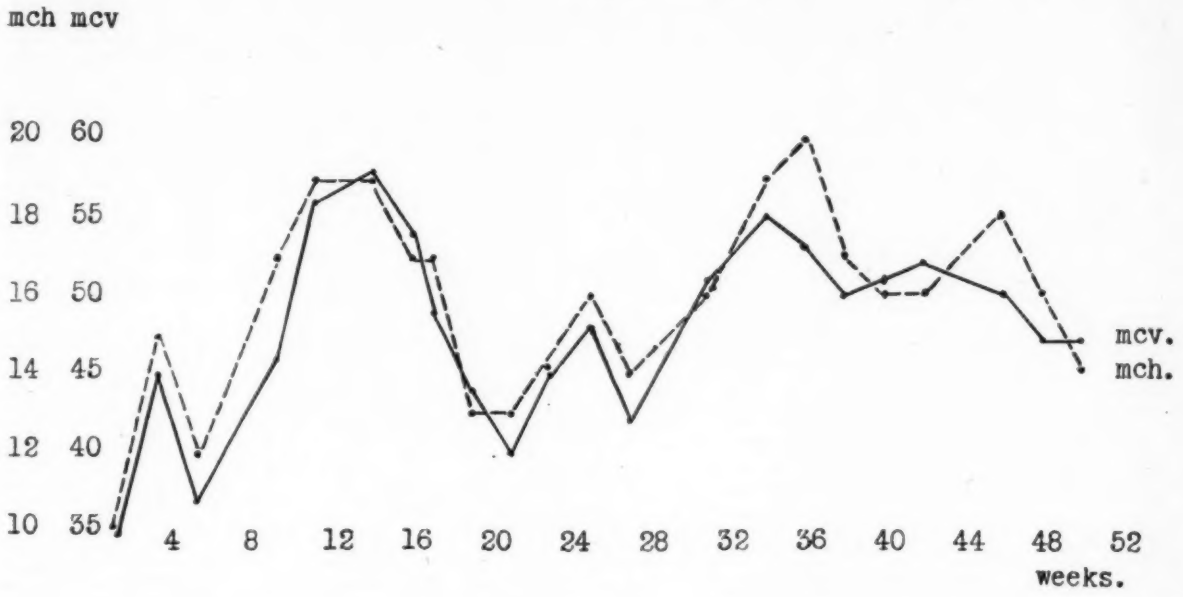


CHART IX.
NUMBER 1082.



animal were haemolysed in normal ox plasma. This is reminiscent of the demonstration by Foy, Altmann, Barnes & Kondi (1943) of destruction of red cells from blackwater fever cases in normal recipients.

The existence of a haemolytic factor is supported by the appearance of blood smears at the time of crisis, by the positive indirect van den Bergh reactions, by the presence of urobilin in the urine of an extreme case, and by the improvement of reticulocyte counts following treatment. The existence of a haemolytic factor is thus beyond doubt. Terminally, as already shown, it is always present, but during the course of the disease it is present only intermittently and to the greatest degree at times of trypanolysis.

While, therefore, haemolysis may be responsible for an acute course of the disease or for a fatal termination at the time of crisis, it is not to be regarded as the underlying cause of the progressive anaemia, which must now be studied further.

2. *The Effect of the Spleen, Bone Marrow and Other Organs.*—The part played by the spleen, haemolymph and lymphatic systems in removal and destruction of red blood cells has already been demonstrated. There can be no doubt that the primary cause of anaemia in the acute stage of the disease lies in a combination of red cell removal in this way and inhibition of the haemopoietic tissues of the bone marrow, whereby the lost red cells are not replaced.

The anaemia is thus caused by: (*a*) removal of red cells; (*b*) destruction of red cells; (*c*) failure of replacements; (*d*) periodical intensification of the condition by haemolysis.

The splenomegaly would appear to be a response to the presence of foreign material in the circulation. Laveran & Thiroux (1907) established the rôle of the spleen in trypanosomiasis as the removal of destroyed trypanosomes. The removal of red cells may thus be a purely mechanical process arising from the fact of splenomegaly. The causes of the increased destruction of red cells are not evident, but there appears to be a general increase in the activity of the macrophage system, which may result in an increased attack on stagnant erythrocytes. The causes of the degeneration and inhibition of the bone marrow are not clear, but the functioning of this organ will be impaired by the same influences, which affect other tissues and which will be considered in the next section.

During the chronic stage of the disease, neither the factors considered above nor the degree of anaemia are sufficient to account for the chronic wasting condition and the generalised parenchymatous degenerations, which are a feature of the disease. It is, therefore, necessary to study the other changes described, in order to discover what part these play.

3. *Changes of the Plasma and Vascular System.*—It has already been shown that, where the disease progresses to the chronic stage, hydraemia is the distinguishing feature. Furthermore, it has been seen that natural recovery only takes place in the absence of specific gravity alterations of the plasma.

From the blood volume studies on No. 3237, *vide supra*, it is evident that the hydraemic form of the disease is accompanied by: (*a*) loss of plasma solids; (*b*) loss of water; (*c*) changes of osmotic pressure, arising from dilution. The character of the blood plasma is thus drastically altered, but in addition important vascular and circulatory changes occur: (*a*) vaso-dilatation; (*b*) decreased circulation time.

These factors are operative throughout the acute and chronic stages of the disease, but only become dominant during the latter. Thus, during the acute stages of the disease, the failure of the blood to deliver oxygen may be the most important factor. During the chronic stages, the important factor is plainly the failure of the plasma to

deliver nutrients. The possibility that plasma failure may be equally important with red cell failure has been widely overlooked in the study of the anaemias of trypanosomiasis, malaria, and the Kwashiorkor group of diseases. And yet the tissue degenerations which are common to these diseases are typical of those arising from amino acid deprivation. The centrilobular degeneration of the liver, in particular, is identical with that of methionine starvation. This conclusion is supported by the observations of French (1935), who showed that trypanosome infected cattle were in negative nitrogen baiance.

It has already been shown that the vascular and plasma changes are a direct effect of the presence of parasites, whether living or dead. It is, therefore, now possible to find an explanation of the progressive nature of the disease during the chronic stages, when the diminution of parasite numbers makes this appear anomalous. Whereas the more acute symptoms of anaemia disappear with the reduction of parasite numbers, there persists a form of physiological starvation.

Discussion

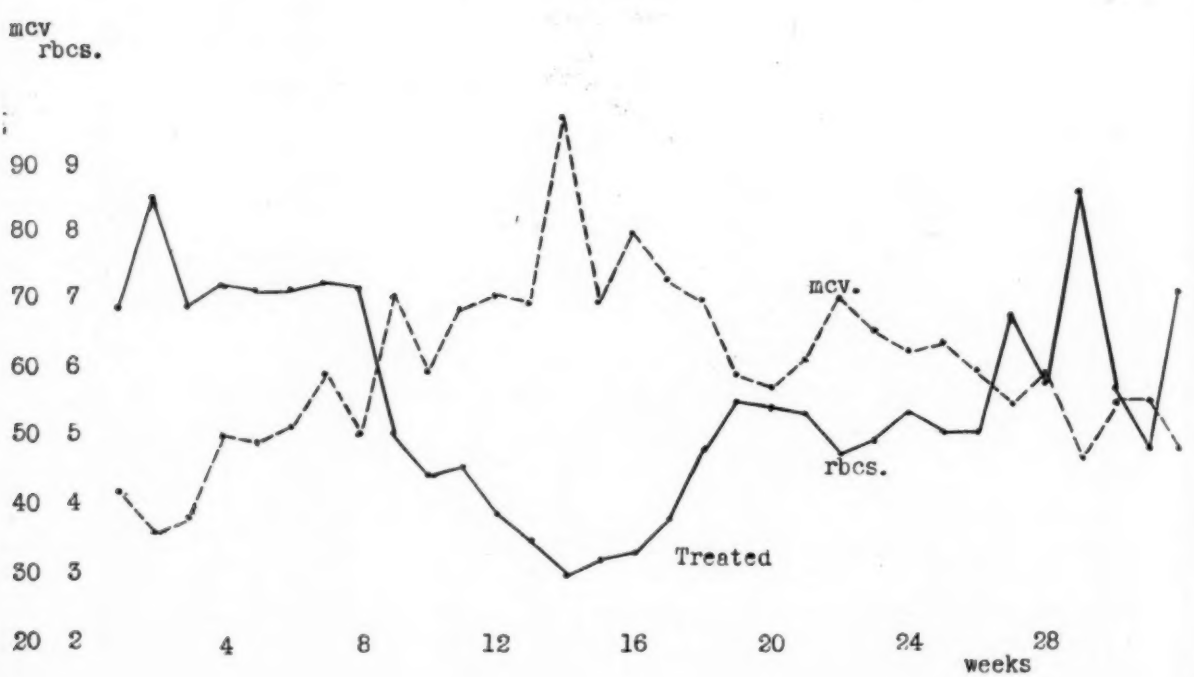
The present investigation was undertaken during the course of studies on trypanocidal drugs, and the time that could be devoted to it was limited. What was intended as a purely routine examination of the anaemia of trypanosomiasis and its causes was inevitably diverted into a wider field. Techniques used previously in the study of the anaemia of trypanosomiasis proved incapable of revealing the manner of the changes which occurred. Hence, almost no literature to which reference could profitably be made has been found on the subject.

It is evident that, in cattle, estimations made on the blood, whether of a physical or a biochemical nature, may be very misleading, because of the dilution factor. This may also be the case in other animals. For instance, Feldman & Murphy (1945) and Overman, Hill & Wong (1949) found changes in the total circulating nitrogen of human malaria patients, which were not revealed by biochemical estimations.

The changes of the blood, which determine the symptoms and course of trypanosomiasis of cattle, are complex, not simple; it is by the interaction of a number of factors that the pathology is determined. These changes can be described as anaemia, only if the term anaemia is used in a very wide sense to cover changes of the blood plasma, as well as of the red cells, and alterations of function of the vascular system, which contribute to the failure of the blood in delivery of oxygen and nutrients. Again, it is customary to describe anaemia as haemolytic or non-haemolytic. Here, we encounter an anaemia which is basically non-haemolytic, but which in the acute stages of the disease contains a haemolytic factor, of greater or lesser importance, depending on the type of case.

It now appears that anaemia, in its narrow sense—that is changes of the red cell and haemoglobin content of the blood—is relatively unimportant in the chronic stages of the disease. The operative factor is the failure of the blood plasma to deliver essential nutrients. This has explained the most difficult problem in the pathology of trypanosomiasis, namely the reason for the progressive parenchymatous degenerations which occur in the post-critical period, when parasite numbers are diminishing and apparently the body defences are mastering the invasion.

CHART X.
NUMBER 8987.



It could have been wished to make these studies on a more extended scale, but this was impossible. It is hoped to extend them at a later date. The interpretations placed on the data, give at long last a satisfactory explanation of the pathology of this most puzzling disease, and it is confidently expected that further work will confirm them.

Summary

1. The blood of normal cattle, under the conditions represented at Kabete, is subject to physiological changes of a large order, reflected chiefly in changes of red cell counts, cell size and cellular haemoglobin, and dilution of the plasma. These changes may occur during the course of a single day, when the chief features are alterations of circulating blood volume and haemo-dilution. There are, also, periodical variations, which are part of an erythropoietic cycle.

2. It was found that a reduced red cell count might be due to haemo-dilution and, in this case, would often represent an increase in the actual numbers of circulating red cells. In cattle infected with *T. congolense*, it was found that the first sequence of the so-called anaemia was, in fact, hydraemia; that is, although red cell counts became reduced, the numbers of red cells in circulation were increased, but were more diluted. Subsequently, a true reduction in the numbers of circulating red cells was found, accompanied by loss of plasma solids.

3. There are two sharply contrasted stages of the disease, the acute and the chronic, which are separated by a crisis. Different factors are responsible for the symptoms and pathology of the disease during the two stages.

4. During the acute stage, there develops severe anaemia, due primarily to removal and destruction of red cells by the spleen and other organs. It is intensified at times of crisis by haemolysis, produced by haemolysin emanating from the bodies of trypanosomes injured by trypanolysin. Haemolysis and trypanolysis occur at the same time and cause the phenomena of crisis and collapse. The anaemia of the acute stage is macrocytic.

5. The anaemia of the chronic stage is microcytic, of less severity, and may indeed be accompanied by high red cell counts. Haematocrit and haemoglobin remain low. It is not the primary cause of the progressive disease.

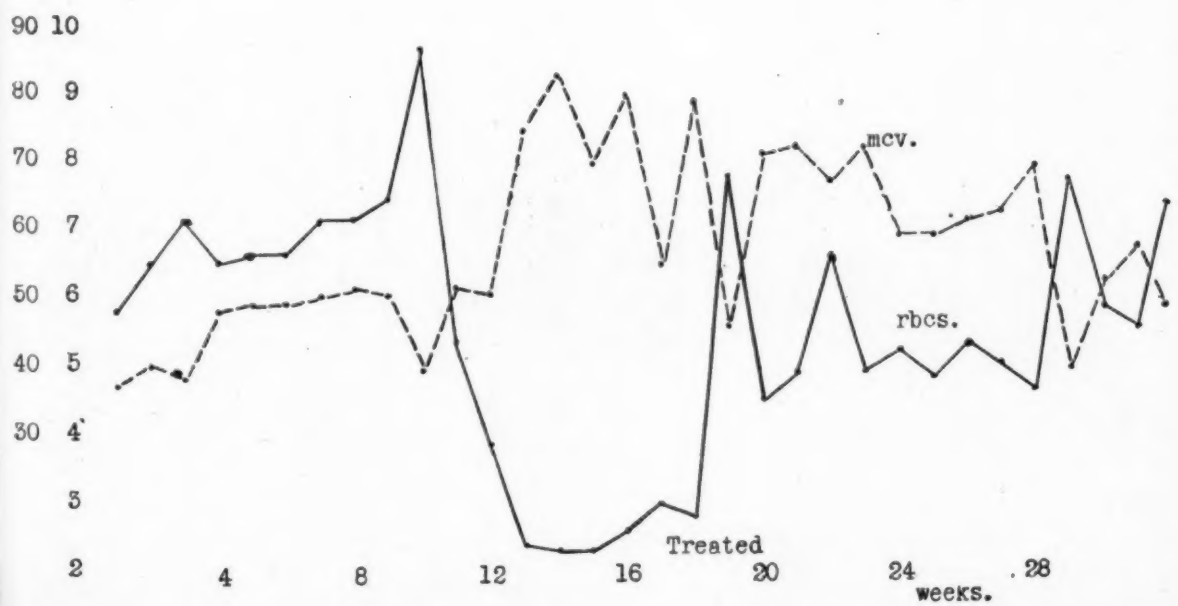
6. During the chronic stage, the wasting condition, terminating in death from extreme inanition is due: (*a*) to dilution of the blood plasma and reduction of its volume and solids content, whereby the total of nutrients offered to the tissues is diminished; (*b*) to circulatory changes, whereby the passage of oxygen and nutrients from the blood to the tissues is impaired. The result is a form of physiological starvation, from which death ensues, even if abundant food is available to the animal.

7. In rare cases natural recovery occurs. In such cases, alterations of the plasma composition are rare or do not occur. This shows that the anaemia, *per se*, is not of great significance during the chronic stages.

Technique

Red Cell Counts.—All red cell counts were made personally by the author. Pipettes were cleaned in distilled water and acetone and were stored until use in a hot cabinet.

CHART XI.
NUMBER 8994.



Haemoglobin Estimations.—A Sahli haemoglobinometer was used.

Packed Cell Volumes.—Wintrobe tubes were used. The blood was centrifuged at 3,000 r.p.m. for 10 minutes.

Specific Gravities.—The copper sulphate method was used.

Blood Volumes.—Vital Red was used for staining the plasma. About 40 c.c. of 1 per cent. solution were injected into the jugular vein, the quantity being dependent on the size of the animal. The sample was withdrawn after four minutes. Comparison of plasma colours was made in the EEL photo-electric colorimeter.

Comparative tests showed that excretion of vital red in the four-minute period was negligible, but that uniform distribution of the dye had occurred. Very little of the dye remained in the plasma after 24 hours, a distinct advantage if it was desired to repeat the test at short intervals.

Blood Samples.—Blood samples were withdrawn into oxalated bottles, prepared according to Wintrobe. Samples were drawn from the jugular vein; the neck was first constricted by a rope, which was released while the sample was being taken.

Acknowledgments.—I acknowledge with deep gratitude my indebtedness to Dr. Henry Foy, of the Wellcome Institute, who was working in Nairobi at the time this work was done. I have relied to a great extent on his advice and have benefited from his unrivalled experience of haemolytic anaemias. Furthermore, such spectroscopic examinations as were done were made by him on my behalf. I am indebted to Mr. M. Lucas, M.R.C.V.S., who assisted me during part of the work. I also express my gratitude to Mr. D. P. Braithwaite, chemist to the Kenya Veterinary Department, who made the blood volume estimations on plasma samples that were given to him.

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THE EUROPEAN RABBIT-FLEA, *SPILOPSYLLUS CUNICULI*, AS A VECTOR OF MYXOMATOSIS IN BRITAIN

BY

R. M. LOCKLEY

The Nature Conservancy, 19 Belgrave Square, London, S.W.1.

As long ago as 1920 Aragao in Brazil found that cat fleas, *Ctenocephalides felis*, which had fed on myxomatous rabbits, were capable for up to 24 hours subsequently of transmitting the disease to healthy rabbits. Similarly Bull & Mules (1944) found that the Australian stickfast flea, *Echidnophaga myrmecobii*, was capable of transmitting the virus of myxomatosis from sick to healthy rabbits. Fenner considers that in Australian conditions the stickfast flea (normally parasitic upon marsupials) may be one of the vectors responsible for the smouldering spread of myxomatosis in winter: but generally speaking mosquitoes and dipterous vectors have been thought to play a much more important rôle. It may be significant that in New Zealand, where myxomatosis was deliberately introduced (1952) but with disappointing results, there are apparently no fleas regularly infesting the rabbit. The purpose of this communication is to record the successful transmission of myxomatosis by means of the European rabbit-flea, *Spilopsyllus cuniculi*, and to suggest that this insect may play a more significant part in the natural or artificial spread of the disease in Great Britain than has been suspected.

During a survey for the Nature Conservancy in January of this year of the extent to which myxomatosis was present in or near Nature Reserves in Sussex, Kent and East Anglia, it was observed that live fleas were resting in the dry fur on the underside of 27 rabbits which were examined, and which had been dead of myxomatosis for several days. Live fleas were found even when there was snow on the ground (January 7th), but were more active on sunny days, and responded by crawling or jumping movements to agitation of the fur. When the skin and fur of the dead rabbit were warmed with the hands, the fleas began to crawl actively against the operator's skin.

Between January and April a series of transmission experiments was therefore attempted in which fleas collected from rabbits dying or dead from myxomatosis were brought to the laboratory and transferred to domestic rabbits. The intervals between death of the original host and placing the fleas on the domestic rabbit ranged from two to eight days. In 7 out of 10 attempts, in which the number of live fleas transferred was 35, 29, 25, 23, 12, 10 and 6 respectively, death from myxomatosis occurred in 11 to 13 days. In the remaining three attempts in which the number of fleas transferred was only four, three, and one respectively, the domestic rabbits remained unaffected. At no time did myxomatosis occur in untreated rabbits on the premises. In a further observation, a flea-infested wild rabbit which had been dead only a few minutes was placed in a hutch overnight with a normal uninfested domestic rabbit. On the following day 24 live fleas were recovered from the domestic rabbit.

During field observations it was found that there was a definite rise in the numbers of fleas counted on wild rabbits between January and June. It was also noted that corvine birds feed immediately on dead myxomatous

rabbits; and it seems feasible that infected fleas may be spread by migrating birds over comparatively long distances, even perhaps from France to England.

I am indebted to Dr. C. H. Andrews (National Institute for Medical Research), Mr. Harry V. Thompson (Infestation Control Division, Ministry of Agriculture & Fisheries), the Wye College Veterinary Staff, and the Hon. Mrs. George Lane (Miriam Rothschild) for advice and suggestions. I am specially indebted to Mr. Alastair N. Worden for undertaking the laboratory tests.

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REVIEW

First Aid and Nursing for Your Dog. By F. Andrew Edgson, M.R.C.V.S., & Olwen Gwynne-Jones. Popular Dogs Publishing Co., Ltd. Price 7s. 6d.

As its title suggests this book is intended solely for the layman. Its style is readable and it contains many facts of interest and some of practical value to the dog owner. Its value as a reference work in emergency, however, is lessened by the inability of its authors to decide more precisely what they are writing about. They entitle their work First Aid and Nursing, then digress into a variety of discussions on diagnosis, causes and prevention of the complaints they describe. For example, *Leptospira canicola* and *L. icterohaemorragiae* vaccination are both discussed and each time a mis-statement is made to the effect that such vaccination gives a permanent immunity. The result is a piece of optimism not shared by the makers of the vaccines and a discussion far removed from first-aid or nursing.

The effect of such digressions, although informative and admittedly of interest, is to leave the book somewhat deficient in essentials and patchy in outline. Nasal discharge has a heading to itself; cough is not even mentioned in the index; pneumonia jackets have a heading, pneumonia itself is not indexed and so on. And, surely, under any heading of abscesses, hypertonic saline might be given a word or two, for what more obvious first aid ingredient would be found in every house than common salt?

If one might proffer advice to the authors it would be to beware of alphabetic arrangement in anything less comprehensive than an encyclopaedia and to tackle first aid in a different section from nursing, with (since the idea of putting it over is a good one) a third section on prophylaxis.

INTERNATIONAL AWARD FOR BRITISH VETERINARY FILM

The Judging Committee of the International Festival of Medical and Scientific Films, held at Turin, has awarded the Bronze Minerva to the film "Transthoracic Oesophagotomy" presented by Mr. Gordon Knight, of the Beaumont Animals' Hospital, Royal Veterinary College, London, and produced by Dr. Peter Cardew.

THE SIXTH COMMONWEALTH ENTOMOLOGICAL CONFERENCE

This Sixth Conference was held at the Royal College of Science from Wednesday, July 7th, until July 16th, and was attended by representatives from 20 Commonwealth and Colonial territories.

The subjects discussed reveal the very important part played by the entomologist in the maintenance of healthy plants and animals.

As one would expect, the use of insecticides had a place of prominence in the discussions, especially as insects have shown the same tendency to develop resistance to the new insecticides as bacteria have to the antibiotics. Among the subjects discussed were "Recent developments in the use of insecticides on field crops," "Effect of the use of chemicals on the balance of animal population," and, of more interest to the veterinarian, "Recent developments in the use of insecticides from aircraft," and "Recent developments in tsetse research and control."

Mr. D. Yeo (Tanganyika), in discussing the aerial treatment of tsetse infested country, revealed that 75 per cent. of Tanganyika is fly infested, which represents an area of approximately a quarter of a million square miles,

Aerial treatments are made at intervals of 14 to 17 days, six to eight applications being made. Oil solutions of DDT or BHC are used and an aerosol is produced by passing the solution into the exhaust of the aircraft. A coarse aerosol particle 60 to 90μ in diameter is formed, which is capable of passing tree trunks, and the branches of trees, to deposit on the breeding sites.

Under favourable conditions, such a treatment gives a 98 per cent. kill of tsetse fly. Treatment costs about £1,000 per square mile.

Dr. J. R. Busvine reviewed the present knowledge on the development of resistance by insects to insecticides. Resistance is generally associated with the abnormal character of individuals or strains of certain species which are prevalent as a result of selective mortality due to insecticides.

Insecticides, however, can fail for other reasons, such as variations in environment, faults in the insecticide or its application, or selective destruction of parasites.

A very important point in the study of resistance is agreement on a reliable method of measuring resistance, and the World Health Organisation is advocating a test of the resistance level of disease-carrying insects, as a prelude to control measures based on insecticides.

It has been found that resistance in the field, after two years of intensive use, occurred in the cattle tick to BHC, the house-fly to DDT and human lice to DDT.

In the case of the house-fly resistant to DDT, a similar resistance within a year of use occurred to BHC, chlordane and Dieldrin.

Laboratory flies resistant to chlordane showed no decline in resistance over a period of four years (80 to 90 generations) in the absence of selection.

The resistance of Boophilus (the one host tick) to benzene hexachloride and in some cases toxaphene, has presented a serious problem to cattle men in South Africa, and South America. Fortunately this tick has not yet become resistant to DDT.

There are still wide gaps in our fundamental knowledge on the mechanism of development of resistance. It has been found however that house-flies may chemically degrade DDT to innocuous DDE.

Continued overleaf, foot of column 1.

CLINICAL COMMUNICATION

TWO SKIN CONDITIONS IN THE DOG

1. A Complaint with Unusual Features

2. A Lesion of the Tail Affecting Certain Breeds

A. H. HOGG
(Leamington Spa)
AND
H. HOLROYD
(Blackburn)

1. The first cases to be described are those of an unusual skin condition seen recently in several dogs. There was no systemic disturbance and the only change seen was a marked thinning of the coat in a circumscribed area which, in some cases, was even more accentuated by an alteration in the colour of the hair at the periphery. There were no signs of local irritation leading to scratching or rubbing and the epidermis appeared normal. The lesion has been seen only on the flank region (see Figs. 1 to 8) and it is bilateral. The uniformity of the shape of the lesions on each side of the body is most striking. Response to treatment varies but as a rule the topical application of the common skin medicaments is not encouraging. The following cases which are described differed in some respects but all had some characteristic points in common. One further case is described which, though superficially resembling the others, almost certainly belonged to a different category of skin disease.

Case 1.

Boxer, female aged two to three years. When first seen was several weeks pregnant. The lesion was delineated by an alteration in the colour of the hair at its periphery and by a sparseness of the coat within the area. (Figs. 1 and 2). The lesion was bilateral and the irregular contours were identical on both sides of the body. (Fig. 3). The shape of these lesions is characteristic of the whole series and the position shown in the illustrations appears to be a predilection site. There were no signs of local irritation and the bitch remained in perfect health throughout the period that the lesion existed. Treatment first consisted of local topical application of ointments and lotions of various kinds. Later these were supplemented with oral administration of various drugs. There was however no response to this treatment and there had in fact been a slight forward extension of the lesion during this period. At this stage it was thought that the condition might in some way be associated with pregnancy and it was hoped that after whelping some natural recovery might ensue. Therefore treatment was withheld for a time and during this period the bitch whelped and reared a normal litter. As there was no improvement at the time of weaning treatment was recommenced and consisted of a series of injections (Becosyn—Roche Products). Improvement was seen after the third injection and eventually the lesion disappeared completely.

Case 2.

Cocker Spaniel, female aged two to three years. Two areas of partial alopecia (sparcity of hair) became apparent in the same regions of the body as in Case 1. The lesion spread forwards on the flanks as the condition progressed. Again the shape and appearance of lesions were identical on both sides and there was no systemic upset or local irritation. This case was first seen about half-way through the treatment of the previous animal which was then receiving liquid thyroid extract orally and a salicylic acid ointment locally. The same treatment was therefore employed and the lesion in this case cleared up.

Case 3.

Bull Mastiff, male aged three years. This case was discovered while the animal was being examined for an entirely different complaint. The owner was unaware of the existence of the lesion until it was pointed out to him. This case was identical with that of the Boxer (Case 1) but no treatment was given in this instance and the end result of the case is not known. The lesion (Fig. 4) was again bilateral, identical on both sides and caused no systemic disturbance in the dog.

Case 4.

Scotch Terrier, female aged three years. This case was not seen at its commencement and most probably it was advanced when it was seen. According to the owner the lesion was first noticed after stripping. The coat then appeared normal on the anterior part of the body but showed no tendency to grow in the region of the rumps and flanks. This statement by the owner may or may not have been an accurate description but in any case when it was first seen the lesions appeared as in Figs. 5 and 6. There was a well-marked line dividing the normal coat at the anterior edge of the lesion which showed sparcity of hair, and was bilateral and identical on both sides.

Treatment was almost identical with that given to the Boxer (Case 1) and a cure was finally obtained only after Becosyn injections. The lesions extended whilst other treatments were being employed and the illustrations are of a stage about half-way.

Case 5

This case is described because it is typical of some which are common and similar to the foregoing cases and may be confused with them. It would probably be classed as a dry eczema or an alopecia according to the diagnostician.

The animal was an Airedale bitch of three years. The lesion apparently commenced as in the other cases but was unilateral (Fig. 7). In spite of treatment the affected area of skin became bald and extended to affect the back

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Commonwealth Entomological Conference—Concluded.

Dr. C. H. N. Jackson (Tanganyika) contributed a very interesting survey of the methods employed for tsetse control, and he emphasised that the suitability of a method will vary from territory to territory.

African territories have varied immensely in their approach to the problem of tsetse eradication. Zululand employed aerial spraying; Rhodesia, game destruction; Tanganyika and Nigeria, bush clearance.

The method employed depends on whether the fly is a riverine species such as *G. palpalis* or a fly requiring less humidity such as *G. morsitans*. It was obvious, however, from Dr. Jackson's paper that the pool of knowledge available on tsetse control should ensure a more rapid reduction of the tsetse population in the future.

This conference demonstrated that the newer insecticides, although producing their own problem in the form of resistant species, have greatly advanced the science of parasite control both on plants and animals.

G. B.

A. H. HOGG & H. HOLROYD: TWO SKIN CONDITIONS IN THE DOG

1. A Complaint with Unusual Features
2. A Lesion of the Tail Affecting Certain Breeds

FIG. 1.—Case 1.

FIG. 2.—Case 1.

FIG. 3.—Case 1.

FIG. 4.—Case 3.

FIG. 5.—Case 4.

FIG. 6.—Case 4.

FIG. 7.—Case 5.

FIG. 8.—Case 5.

and both sides of the body to an equal extent (Fig. 8). A cure in this case was obtained only after a series of Becosyn injections.

Discussion

The first three cases were undoubtedly one and the same complaint. The fourth case (Scottish Terrier) is also similar but diagnosis would have been easier if it had been seen at an earlier stage. The fifth case (Airedale) is entirely different and has only been included to bring out the salient features of the condition under discussion. The condition as described in the first four cases probably lends itself to spontaneous recovery and little importance is attached to the result of treatment in the limited number of cases quoted. The apparent response however may be suggestive.

It is felt that it is unnecessary to enumerate the various points in differential diagnosis such as elimination of parasitic and fungal infection. Neither will any surmises regarding aetiology be made at this stage but it is hoped that publication of these cases may encourage others to record further examples.

* * * * *

2. The second skin condition to be described is one when there is a marked predilection site on the tail. It is remarkable that the lesion has not been described before especially when the aetiology is apparently unknown. If however the description given encourages others to agree on the question of aetiology the purpose of this communication will have been served. The condition is only seen in such breeds as Bull Mastiffs, Bull Terriers, Smooth Dachshunds, and Great Danes. A lesion is seen which consists of a small area of thickened or toughened skin situated about half-way down the tail on the dorsal aspect. The hair on the lesion is scanty, and often broken and discoloured so that, in White Bull Terriers for example, it appears as if it were covered by a smudge of oil stain. The size of the lesion may be up to that of a human thumbprint but not larger than this. The animal shows no other symptoms and the skin lesion remains unaltered for long periods of time and probably indefinitely. On questioning the owners they almost invariably state either, that it is due to friction from sitting down, or, that they were unaware of its existence and did not realise that it was a defect. In one case of a six-weeks-old Bull Mastiff the skin was seen to be thickened but the hair over the area was normal. No suggestion can be made as to the aetiology of this tail blemish but it may well be that it is in some way connected with demodectic mange.

HOSPITALITY FOR SWISS STUDENTS

The Acting Principal of the Royal Veterinary College has forwarded the following letter, addressed to him by two Swiss veterinary students:—

"We are two veterinary students of Berne University, who would like to work as assistants with an English veterinary surgeon, from August 15th to September 15th. We would be very grateful to you, if you could give us some addresses of veterinary surgeons, where we could do some practical work. We have studied nine semesters at the Veterinary School of Berne and have done some practical work too. We are very interested to know how English veterinary surgeons do their work and would like, at the same time, to improve our English.—(Sgd.) H. Luginbuhl, H. Steffen, cand. vet. Blumensteinstr. 7. Bern."

Their professor adds: "I recommend these two young men very much and it would be a pleasure to me also if places could be found for them in England.—(Sgd.) Professor E. Frauchiger, Universitat Bern, Vet. ambulatorische Klinik, Abt. fur vergleichende Neurologie."

ABSTRACTS

Birds and Viral Encephalitis

The most obscure feature of the epidemiology of West Nile virus infection, and the St. Louis, Japanese B and Murray River encephalitides is the reservoir of the virus during the winter, or in the case of the two latter viruses, the reservoir from which the infection periodically invades areas in the temperate zones.

There are two theories on the subject, both involving birds. The first theory postulates that the encephalitis virus survives the winter in chicken mites, and infection is passed on through the eggs and larvae, with the possibility of indefinite survival apart from vertebrate hosts. St. Louis virus is known to occur in chicken mites and in view of the close similarity in the biological behaviour of the other three related viruses, it is possible that a mite-bird cycle may occur with them also.

The second theory suggests that Murray Valley encephalitis virus for example may be confined to tropical regions, where vector mosquitoes are persistent throughout the year, and from there may be carried by migrating birds to temperate regions in the summer. Exceptional meteorological conditions, causing exceptional bird migrations, might then account for the appearance of Murray Valley encephalitis in Southern Australia at long intervals of time.

I. W. J.

* **Birds and Viral Encephalitis.** (Annotation). (1954). *Brit. Med. J.* 977.

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A Biological Approach to Medical Geography

For those interested in preventive medicine, the author suggests a new approach to the subject of medical geography, namely the study of the whole assemblage of parasites in their relationship with the host population. The parasite patterns which emerge from such a synecological approach are considered to be decided largely by environment—that is, by the geographical background in the case of animals. In the case of man, the geographical background becomes altered by cultivation of land, urbanisation, and industrialisation, and these involve changes in the disease patterns. But still the patterns are broadly related to environment and the change is largely one of emphasis.

An interesting example of this type of study is provided by investigation of the parasite patterns of squirrels and rats in the rain-forests of Malaya. The tree-living squirrels support some 30 species of parasitic mites, which together make a pattern broadly characteristic for these squirrels. Ground rats in the same area have a quite different parasite pattern. One species of rat, however, has a pattern resembling that of the tree squirrels. The correct inference from this is that this species lives in the trees, like the squirrels. And again, there is a type of ground squirrel whose parasite pattern is like that of the ground rats. This lends support to the hypothesis that the parasite pattern is directly related to the environment, to the conditions of life, and to the way of living of the host.

The technique then, is to study the component parts of the host-parasite relationship in isolation, and then to integrate them into an organised system or pattern, and study that system as an organism in its entirety.

I. W. J.

* **A Biological Approach to Medical Geography.** Audy, J. R. (1954). *Brit. Med. J.* 960.

QUESTIONS IN PARLIAMENT

Myxomatosis

Mr. Peter Freeman (July 15th) asked the Minister of Agriculture, in view of the deliberate spreading of myxomatosis on a wholesale scale throughout many areas of the country and the suffering being inflicted thereby on the rabbits involved, whether he will recommend other methods of destroying these animals, such as by humane trapping, gassing or netting; and whether he will take steps to prohibit the further spreading of this disease.

Sir T. Dugdale: All humane methods of destroying rabbits have been and will continue to be recommended. As regards the last part of the Question, I would refer the hon. Member to the reply I gave to the hon. Members for Nottingham East (Mr. J. Harrison) and Billericay (Mr. Braine) on July 8th.

Major Anstruther-Gray asked the Minister of Agriculture how much further myxomatosis has spread among rabbits in the last fortnight; and how many cases have been confirmed north of the Border.

Sir T. Dugdale: During the past fortnight outbreaks of myxomatosis in wild rabbits have been confirmed in Breconshire, Caernarvonshire, Carmarthenshire, Dorset, Flintshire, Herefordshire, Northamptonshire and Warwickshire; and I understand that the first outbreak north of the Border was confirmed on Tuesday this week in Kincardineshire.

NOTES AND NEWS

Diary of Events

July 28th.—Meeting of the Supplementary Veterinary Division, B.V.A., at 7, Mansfield Street, Portland Place, London, W.1, 2 p.m.

Sept. 19th—25th.—72nd Annual General Meeting and Congress of the British Veterinary Association at Torquay.

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THE ROYAL GARDEN PARTY

The following ladies and gentlemen were present at the first of Her Majesty's Summer Garden Parties, held in the grounds of Buckingham Palace on July 15th.

Dr. W. R. Wooldridge, President of the R.C.V.S., and Miss Sylvia Wooldridge; Mr. A. Thomson, President of the B.V.A., and Mrs. Thomson; Mr. A. M. Graham, Senior Vice-President of the B.V.A., and Mrs. Graham; Dr. A. W. Stableforth, Director of the Ministry of Agriculture Veterinary Laboratory at Weybridge, and lady; Mr. and Mrs. Howard Dawes; Mr. and Mrs. N. P. Male; Mr. W. G. R. Oates, Registrar of the R.C.V.S., and Mrs. Oates.

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PERSONAL

Engagement.—Brunsdon—Richards.—The engagement is announced between John Richard Brunsdon, M.R.C.V.S., younger son of Mr. and Mrs. A. F. E. Brunsdon, 4, The Chase, Reigate, Surrey, and Jean Mary Richards, only daughter of Mr. and Mrs. E. G. Richards, "Protea," 1, Ashwell Lane, Glastonbury, Somerset.

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Birth.—Bowler.—On July 12th, 1954, to Vivienne (*née* James) wife of Geoffrey Bowler, M.R.C.V.S., 47, Endless Street, Salisbury, Wilts, a daughter—Penelope Jane.

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Dr. F. H. Manley, Professor in the Department of Bacteriology, Alabama Polytechnic Institute, will be among the overseas scientists present at the World Poultry Congress in Edinburgh next month.

Mr. Andrew Crosbie, M.R.C.V.S., of Beith, Ayrshire, has been appointed to the Colonial Veterinary Service as a Veterinary Officer in Northern Rhodesia. He sailed from the U.K. in the s.s. *Pretoria Castle* on July 15th, 1954.

He has served in Doncaster, Leigh and Scunthorpe, and has held appointments as local Veterinary Inspector to the Ministry of Agriculture since 1942.

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OBITUARY

McLellan, John Young, M.P.S., of "Ingrebourne," Willow Avenue, Lenzie, Nr. Glasgow. M. and B. veterinary representative in Scotland. Died July 10th, 1954, aged 43 years.

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ROYAL COLLEGE OF VETERINARY SURGEONS

List of Successful Candidates

Dublin

Second Examination:

Both Subjects.—Hoban, G. P.

Physiology only.—Devereux, W. R.; Dolan, T. C.; O'Neill, J. J.; Wallace, James.

Anatomy only.—Atock, E. A., Doyle, I. N.; Jones, R. F.; Kelleher, J. F.; McLaughlin, David; Mansfield, M. P.; Martin, W. H.; O'Neill, Alexander, Schlesinger, Percy; Sheehan, T. J.

Third Examination:

Hygiene only.—Allen, R. S.; Cotter, William; English, R. G.; Handcock, W. J.; Johnston, J. B.; Kelly, D. A.; Kent, D. K.; Kelleher, D. L.; Lee, J. G.; Mangan, P. J.; Moloney, J. B.; Murphy, P. A.; O'Connor, J. J.; Taylor, B. O'C.

Pathology only.—Barry, K. T.; Broderick, T. I.; Boyd, J. R.; Brownell, T. A.; Cawdery, M. J.; Conroy, P. J.; Crowley, J. P.; Dowdall, F. J.; Fleury, A. T.; Gahan, M. A.; Harris, Miss M. D.; Harris, R. E.; Huey, J. A.; Hartigan, P. J.; Mackessy, E. J.; Nunn, W. R.; O'Brien, J. P.; O'Neill, T. J.; Poole, D. B. R.; Smith, K. J. (Credit); Smyth, L. J.; Stuart, N. C.; White, J. J.; Wilson, D. J.

Final Examination:

Abrahamson, D.; Byrne, J. G.; Deevey, W. E.; Fenlon, P. J.; Flavin, M. J.; Gould, M. C.; Guerin, W. A.; Guven, M. N.; Hannan, John; Harbord, R. S.; Keane, P. A.; Kent, Martin; Liffey, P. K.; Littlewort, M. C.; Marsh, J. H.; McDonald, P. J.; O'Brien, M. W.; O'Keeffe, D. J.; Quirke, J. M.; Strickland, K. L.; Twomey, Thomas; O'Dowd, P. W.; Taaffe, G. F.; Tubridy, T. J.

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R.S.I. AND FOOD HYGIENE REGULATIONS

The Royal Sanitary Institute has intimated its "disappointment" to the Minister of Food that the original proposed draft regulations relating to food hygiene have been withdrawn, and that most of the essential points contained therein have been relegated to Codes of Practice

"The proposed new regulations are," it says, "in the Institute's opinion, totally inadequate since they do not provide for any important additional powers not already contained in the existing legislation."

The Institute goes on to say that if, however, Codes of Practice are adopted, they may serve a useful purpose proyided they are operated for a limited period of, say, five years, and subsequently reviewed. The essential points in the Code of Practice could then be incorporated in the regulations.

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FOR GIRAFFE TRAVEL

Sixty animals from Kenya, unloaded at Sunderland recently, included a female giraffe, who, for the road journey to London, was transferred to a crate specially designed to keep her head down while she was passing under low bridges.

ANIMAL WELFARE ON DARTMOOR

An R.S.P.C.A. investigation into allegations of cruelty to ponies, cattle, and sheep on Dartmoor has led Dartmoor Commoners' Association to approve a nine-point plan " to improve animal husbandry " on the moor.

A letter from the society which was read at the meeting claimed that the report of its inspector justified the society's concern in the past about the condition of animals on the moor. It suggested that overstocking was the main cause of the trouble.

It was unanimously decided to send to the society a denial that the moor as a whole is overstocked, or that cases of cruelty to animals are nearly as widespread as suggested. " It would be in the interest of the association that the R.S.P.C.A. prosecute where these cases of cruelty can be proved," the reply stated. Cattle, sheep, and ponies were bred to stand the normal winter, and the association were satisfied that the moor as a whole was not overstocked. Official figures proved that point so far as cattle and sheep were concerned.

The nine-point code for animal welfare is to be sent to local commoners' committees for discussion. It recommends that ponies should be looked after in severe weather and that closer attention should be paid to stallions, which should be of good type and limited in number. For cattle it recommends that attestation be instituted so far as is possible.

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NEW DIRECTOR OF THE MOREDUN INSTITUTE

Dr. John T. Stamp will take over the Directorship of the Moredun Institute of the Animal Diseases Research Association at Gilmerton, Edinburgh, on October 1st.

This was announced recently at the annual general meeting of the association. Dr. Stamp will succeed Dr. J. Russell Greig, who has been Director of the Institute for nearly 25 years.

Dr. Stamp graduated B.Sc., M.R.C.V.S. from the Royal (Dick) Veterinary College and the University of Edinburgh. He afterwards held the post of lecturer in pathology at the Dick College and obtained the degree of Doctor of Science from the University of Edinburgh.

Since 1946 he has held the post of Principal Veterinary Investigation Officer to the Edinburgh and East of Scotland College of Agriculture. He is a Fellow of the Royal Society of Edinburgh and a member of the Pathological and Bacteriological Society of Great Britain. He is also senior examiner in Veterinary Pathology and Bacteriology for the Royal College of Veterinary Surgeons and external examiner in these subjects for the University of Bristol and the National University of Ireland.

In the course of the meeting Dr. Greig gave a brief retrospect of his period of office, recalling the progress made since the 1920s when " veterinary research, what there was of it, was largely sporadic and freelance in character."

He paid warm tributes to his staff and also to his successor, Dr. Stamp. " In the relatively short period of its existence," he said, " Moredun has experienced many failures and disappointments, but it has also been instrumental in providing new knowledge which has not only enriched biological science but reduced the economic losses from animal disease suffered in agriculture."

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ADDRESSES OF DISEASE-INFECTED PREMISES

The list given below indicates, first, the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

Anthrax:

Berks.—Frilsham Home Farm, Yattendon, Newbury (July 14).
Cornwall.—Treleaver Farm, Coverack, Helston (July 19).
Hants.—Manor Farm, Abbotts Ann, Andover (July 19).
Leics.—Home Farm, Station Road, Upper Broughton, Melton Mowbray (July 13); Forest House Farm, Bardon Hill, Leicester (July 17).
Northants.—Mill Farm, Warmington, Peterborough (July 15).
Renfrews.—Bogside Farm, Inverkip, Greenock (July 12).
Somerset.—Pevilings Farm, Horsington, Templecombe (July 13).

Fowl Pest:

Lancs.—Bough Gap Farm, Trawden, Colne (July 15); 4, Plox Brow, Tarleton, Preston (July 17).
Leics.—86, Coleman Road, Leicester (July 13); Goldsmith Grange, Thorpe Arnold, Melton (July 14); Brooklands, Thurncourt Road, Leicester (July 16); " Marwin," The Common, Barwell, Leicester (July 17).

Swine Fever:

Brecon.—Ty-Gwyn Farm, Gilwern, Abergavenny (July 19).
Cambs.—Upwell Road, March (July 16); 16, Park Road, Sutton, Ely (July 17); Grip Farm, Linton (July 19).
Ches.—55, Borrowdale Road, Moreton, Wirral (July 13); Shavington House Farm, Shavington, Crewe (July 12); Dairy Farm, Whatcroft, Northwich (July 19).
Derbys.—Grove Farm, Hollington, Derby (July 12).
Devon.—Greenswell Farm, Moretonhampstead, Newton Abbot (July 13); Hitchcombe Farm, Lee Mill, Ivybridge (July 14); Piles Peak, Bittaford, Ivybridge (July 16); Chaddlewood Farm, Plympton (July 16); Folder Green Cottage, Broadhempston, Totnes (July 19).
Essex.—55, Marlborough Road, Colliers Row, Romford (July 15).
East Suffolk.—Hall Farm, Westhorpe, Stowmarket (July 13).
Glos.—Climperwell Farm, Blimpsfield, Cranham (July 16); Horton Road, "B" Corporation Allotments, Gloucester (July 19)
Hants.—" Chenies," Headley, Bordon (July 10).
Hereford.—Bosbury House, Bosbury, Ledbury (July 15).
Isle of Ely.—16, Park Road, Sutton (July 17).
Kent.—Primrose Lodge, Blowers Wood, Wigmore, Gillingham (July 16).
Lancs.—Hough End Farm, Chorlton-cum-Hardy, Manchester, 21 (July 16); Dagnalls Bridge Farm, Crank Road, St. Helen's (July 9); Peasley Cross Lane, St. Helen's (July 9).
Mon.—" Magdella," Broadstreet Common, Nash, Newport (July 15).
Norfolk.—The Holiday Camp, Heacham, Kings Lynn (July 12); Manor Farm, West Dereham, Kings Lynn (July 13); Bankside Farm, New Common Marsh, Terrington St. Clement, Kings Lynn (July 14); The Holdings, Clenchwarton, Kings Lynn (July 15).
Oxford.—Old Kew Farm, Kidmore End, Reading (July 13).
Salop.—Lion Lane Farm, Northwood, Shrewsbury (July 14); Moreton Cottage, Cound, Shrewsbury (July 9); Adderley Lodge, Adderley, Market Drayton (July 19); 7, Chuddley, Wellington (July 19).
Staffs.—The Roundhouse Farm, Fradswell, Stafford (July 12); Bridge Cottage, Norton Bridge, Stone (July 12); Bolton Gate Farm, Weston Coyney, Stoke-on-Trent (July 12); Knightsland Farm, Highwood, Uttoxeter (July 13); Gorse Cottage, Swansmoor, Great Haywood, Stafford (July 15); Birch Hall, Ingestre, Stafford (July 15).
W. Suffolk.—Fox Farm, Brockley, Bury St. Edmunds (July 16).
Wilts.—Homefield Farm, West Ashton, Trowbridge (July 12).
Worcs.—Warren Allotments, Evesham Road, Astwood Bank, Redditch (July 12).

CORRESPONDENCE

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the B.V.A.

THE REPORT ON MEAT INSPECTION

Sir,—While the Report on Meat Inspection can be calculated to influence favourably Parliamentary and public opinion, the argument directed at our legislators could be weighted considerably by urging two important functions by one and the same veterinary inspectorate: (1) meat inspection to safeguard the human consumers, and (2) *post mortem* examination of all slaughtered animals as part of a disease control service (*vide* your editorial of March 20th).

Such a dual function would be more attractive to M.P.s and to taxpayers, especially now that the people are alive to the importance of home produced food.—Yours faithfully, J. Tweedale Edwards, Harden Park, Alderley Edge. *July 14th.*

B.V.A. 72nd ANNUAL CONGRESS

Torquay, September 19th to 25th, 1954

LIST OF HOTELS

We publish below a list of the principal hotels in Torquay. The Congress centre, where the Annual Banquet and certain other Social Functions will be held, will be the Palace. In making their reservations members are advised to mention that they are visiting Torquay for the purpose of attending the Congress. Should none of the hotels listed below be suitable for members' requirements or should they have no accommodation left, a further list is available from the Torquay Hotels Association, 9, Vaughan Parade (Telephone 3367).

Name and address	Telephone	Rooms		Garage	Daily Terms
		Double	Single		
Abbey Lawn, Belgrave Crescent	2791	49	11	Car Park	25/6 to 32/6
Argyll Hall, Warren Road	4614	26	6	Yes	30/–
Carlton, Daddyhole Plain	7633	32	26	30 cars	30/– B. & B. 21/6
Conway Court, Warren Road	2088	26	8	Yes	42/–
Devonshire, Park Hill Road	4850	53	9	Lock-ups	21/–
Foxlands, Babbacombe	88072	31	12	20 cars	30/–
Grand, Torbay Road	2234	80	60	75 cars	42/– to 48/–
Imperial, Torquay	4301	60	60	50 cars	45/– to 65/– B. & B. 30/– to 45/–
Links, St. Marychurch	87211	16	19	Yes	35/–
Livermead House, Sea Front	4361	45	25	Yes	27/6 B. & B. 19/6
Osborne, Meadfoot Beach	2232	55	42	50 cars	36/– to 45/–
Oswald's, Babbacombe	88420	41	9	Yes	From 25/–
Palace, Torquay	2271	90	54	100 cars	41/– to 60/–
Palermo, Babbacombe	88442	24	3	Ample parking	27/6
Palm Court, Sea Front	4881	62	32	Near	From 25/–
Phyllis Court, Torbay Road	443311	30	9	Lock-ups and Parking	26/– to 42/–
Princes, Park Hill Road	2816	41	14	Yes	21/– to 36/–
Queens, Victoria Parade	4324	39	14	100 cars nearby	33/– to 39/–
Hotel Regina, Victoria Parade	2904	50	25	Yes	35/– to 42/–
Rising Sun, Belgrave Road	372011	3	1	Yes	21/–
Hotel Riviera, Park Hill Road	7174	38	12	Yes (9)	30/– to 42/–
Rosetor, Chestnut Avenue	4391	40	39	Yes	42/–
San Remo, Belgrave Road	3760	25	13	Parking	30/– to 39/–
Torbay, Torbay Road	2218	51	45	Yes	35/– to 45/– + 10% gratuities
Trecarn, Palermo Road, Babbacombe ...	870881	49	31	Yes	From 27/6
Victoria, Belgrave Road	7501	60	24	Adjacent	33/– to 50/–
All the above are licensed					
Ashley Court, Abbey Road	241711	21	5	Yes	15/– to 25/–
Anstey's Manor, Asheldon Road	3679	25	9	Parking	22/6 to 35/–
Babbacombe Bay, Downs Road	888711	20	7	Nearby	21/– to 27/6
Cavendish, Belgrave Road	3682	35	15	Parking	24/– to 30/–
Chelston Hall, Old Mill Road	65520	21	7	Parking	21/– to 30/–
Chillingworth, Belgrave Road	218511	36	8	Parking Free	27/– to 35/–
Collingwood, Braddons Hill Road E. ...	344811	23	2	Yes	18/– to 25/–
Cumberland, Braddons Hill Road	2379	30	10	Yes	21/– to 27/6
Derwent, Belgrave Road	3452	21	5	Yes	18/– to 27/6
Dorchester, Daddy Hole Plain	4155	57	3	Lock-ups	As Brochures, Less 20%
Elmington, St. Agnes Lane	65192	26	16	Yes and Parking	18/– to 30/–
Hazelwood, Belgrave Road	241411	21	4	Nearby	18/– to 25/–
Heywood Tower, Hr. Warberry Road ...	3837	30	10	—	From 30/–
Hove Mansions, Furze Hill Road	2307	26	4	Parking	21/– to 25/–
Kistor, Belgrave Road	3219	21	8	Adjoining	25/– to 35/–
Rock Walk, Torquay	208711	25	4	Adjacent	30/–
Roselea, Chestnut Avenue	3001	12	14	Yes	36/–
Roslin Hall, Belgrave Road	4373	36	14	Yes	30/– to 33/–
Sefton, Babbacombe	88400	40	8	Lock-ups	30/–
South Devon, Babbacombe	88742	22	6	Free Parking	18/6 to 25/6
Templestowe, Tor Church Road	4911	40	5	Parking	24/– to 30/–
Toorak, Chestnut Avenue	7135	60	40	Yes	From 24/–
Tourine, Tor Church Road	3394	30	7	Free Parking	From 18/–
Vernon Court, Warren Road	2676	35	15	Parking	27/– to 33/–
Villa Como, St. Lukes Road S.	3071	23	3	Yes and Parking	26/6
Wellswood Hall, Wellswood Avenue ...	3746	17	14	Lock-ups and Parking	21/–